Arthroscopic Assisted Reconstruction of LT-Ligament: A Description of a New Technique

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J Wrist Surg 2021;10:2–8.

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Abstract

Background Injuries of the lunotrirquetral ligament (LT lig) could be part of an extensive carpal injury and are then often treated at the time of the injury. However, when an injury of the LT ligament occurs alone, the injury is often missed. Treatment of this injury has traditionally been by open surgery, such as reattachment of the LT ligament, ligament reconstruction, or arthrodesis of the LT joint. These procedures needed a large exposure to the carpus running the risk of damaging the external ligaments, the nerves important for proprioception, and the capsule with the potential of scarring and adhesions.

Materials and Methods We describe a novel arthroscopic assisted technique for reconstruction of the LT ligament. Using this less invasive technique, there is a possible advantage of lesser scarring and faster mobilization.

Results We have performed this technique in two patients with more than 30 months follow-up. They both have great improvement of the functional scores.

Conclusion The novel arthroscopic assisted technique for LT lig reconstruction is a technically demanding procedure; however, this obtains good clinical results with more than 30 months follow-up due to less exposure of the carpus.

Level of Evidence This is a Level IV, case series study.

Keywords
- lunotriquetral ligament
- extensor carpi ulnaris
- reconstruction
- arthroscopy

Tears of the ligament between the lunate and triquetrum (LT-lig) are reported to occur 15 to 20% as common as scapholunate ligament (SL-lig) injuries.[1] The mechanism of injury is suggested to be fall on an outstretched wrist with axial loading on the ulnar side of the wrist that is held in a radial and pronated position.[2] This is a reverse mechanism of what is described for a perilunate dissociation. An injury of the LT-lig is probably often missed and is found as part of a more extensive injury of the carpus involving other bones and ligaments.[3–5] The true incidence of an isolated LT-lig lesion is still unknown. Cooney[6] concluded that arthroscopy is the most precise diagnostic tool in indicating the location, size, and extent of ligament injuries of the wrist and should be considered the gold standard for examining the wrist and LT-lig injuries. For acute injuries, arthroscopically assisted reposition and stabilization with Kirschner wires (K-wires) or screws followed by immobilization should give the LT-lig a chance to heal with a good outcome. For more chronic injuries, arthroscopic debridement, reposition, multiple pinning to create a fibrodesis have been suggested; however, no prospective randomized study has been performed to verify the results.[7] In a retrospective study of LT-lig injuries in a group of patients where almost all patients were classified as subacute or chronic, the authors performed a comparison of arthrodesis, ligament reconstruction, and ligament repair.[8] They concluded the best outcome, with less reoperations, was found in the group where a ligament reconstruction using a slip of the extensor carpi ulnaris (ECU) tendon was performed. We have performed this open technique; however, it needed a wide exposure of the wrist (►**Fig. 1**). As wrist arthroscopy has

received
June 25, 2020
accepted
July 15, 2020
published online
September 14, 2020

DOI https://doi.org/10.1055/s-0040-1716354.
ISSN 2163-3916.

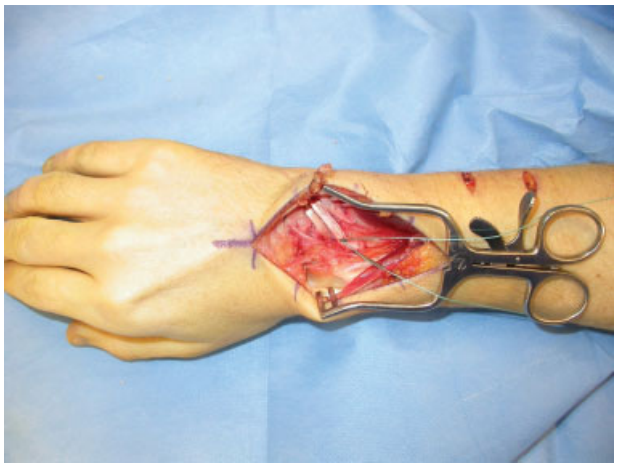

Fig. 1 Open reconstruction of the LT lig using a slip of the ECU tendon needs a wide exposure with possible damage of the ligaments and the capsule, giving more scarring and could delay rehabilitation. ECU, extensor carpi ulnaris; LT lig, lunate and the triquetrum ligament.

gained popularity and our skills have improved, we wanted to develop a new arthroscopic assisted technique using a slip of the ECU tendon passing through the triquetrum and the lunate to reconstruct the LT-lig. By using minimal invasive surgery there should be less damage to the nerves and the carpal ligaments to preserve proprioception. The technique has been tried out in cadavers and in two patients; the technique is described here.

Technique

The patient is supine on the operating table. We use general anesthesia and a tourniquet, the arm is prepared and placed in a traction tower, and we establish the 3–4, 6-R as well as the midcarpal radial and ulnar portals. We use "dry" arthroscopy, however, "flushing" the joint whenever necessary, thus having a shaver available at all time to clean out the joint. An arthroscopic examination of the radiocarpal as well as the midcarpal joints is performed to confirm the diagnosis of a LT-lig tear and instability. Having confirmed that the bone, the cartilage, and the other ligaments are fine, we can decide to go on with the planned procedure.

We now establish the 1–2 portal for the arthroscope to have a view of the SL interval (that can also be viewed from the 6-R portal). Through the 3–4 portal we place a special drill guide (Parallel Drill Guide, 3.5 Compression FT Screw System; Arthrex Co., Naples, FL) with several holes around the center hole, through which we insert a 1.1-mm K-wire into the center hole (►**Fig. 2A–C**). Using a fluoroscope in a horizontal position we can identify the correct direction for the K-wire. We aim for the K-wire to enter the lunate just next to the SL interval (which can be verified by the scope from the 1 to 2 portal), the point of entry should be midway between the proximal and distal part of the lunate. We aim for the pisiform with the K-wire, the K-wire being close to horizontal; thus, the tunnel should be running from a radial dorsal position in a palmar and ulnar direction through the lunate. After having drilled the K-wire through the lunate we check the position using fluoroscope. If the position is not optimal, we can use one of the other holes in the drill guide to have the position of the K-wire we desire. Having confirmed the good position, we use a 2.8-mm diameter cannulated drill to make a hole through the lunate. (The size of the hole could vary depending on the size of the carpal bones in the patient operated upon; however, we prefer to use 2.8 mm of diameter, however, not more than 3.0 mm of diameter). We then take the hand from the traction tower and put it down on the operating table.

We now harvest the tendon slip of the ECU tendon. We make a longitudinal skin incision over the distal part of the ECU tendon, identify the tendon, and avoid any nerves. Having identified the ECU tendon, we palpate the tendon proximal to the wrist where we make one or two transverse incisions in the skin. We aim for a length of 14 to 16 cm for

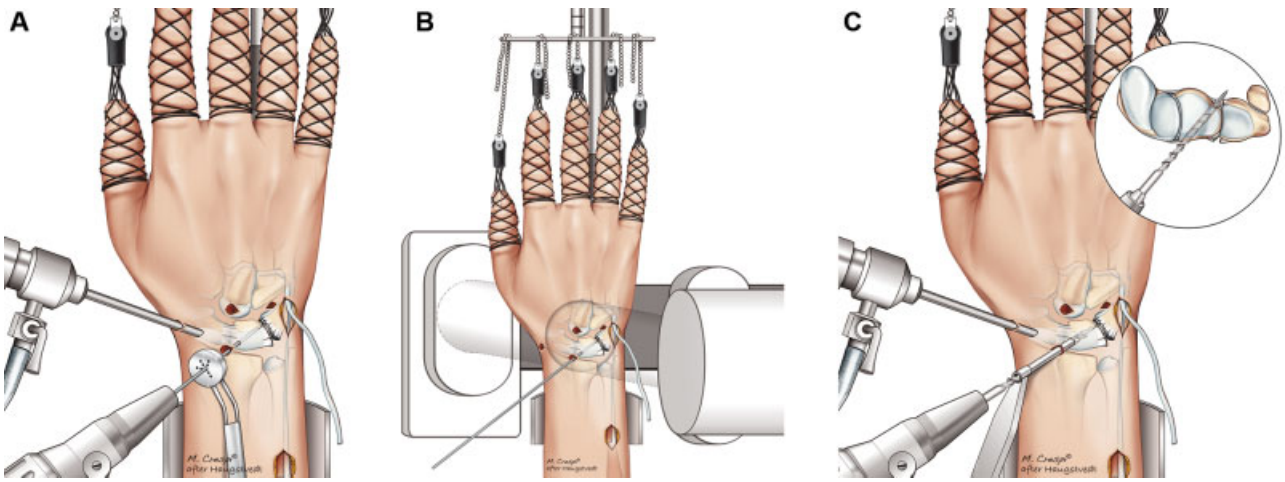

Fig. 2 (**A**) Having the scope in the 1–2 portal, we can view the SL interval. We enter the drill guide through the 3–4 portal, push the K-wire through the guide and drill through the lunate where the entrance point can be viewed from the 1–2 portal. We aim for the pisiform on the palmar, ulnar side of the carpus. The direction is checked using fluoroscope. (**B**) With a fluoroscope in a horizontal position, we can check the position of the K-wire. We will have the possibility to change the position of the K-wire by drilling a new hole through the drill guide if needed. (**C**) When the position is good, we use a cannulated drill to make the hole through lunate. SL, scapho-lunate. Image Courtesy: Wrist Arthroscopy Techniques.[9]

Fig. 3 While preparing for the ECU tendon slip, the arm is placed on the operating table and the tendon slip is harvested through small skin incisions. ECU, extensor carpi ulnaris.

the tendon slip. Using a pre-prepared homemade device made of a cerclage wire (►**Fig. 3**), we insert this through the ECU tendon sheath from a distal and in a proximal direction. We identify the device in the forearm, plan to use a slip with a width of 2.5 to 3 mm, cut the tendon and enter the part planned for the reconstruction into the device and pull the tendon slip into the field around the insertion of the ECU tendon. The tendon slip that will be used for the transfer is prepared.

The next step is to establish a tunnel through the triquetrum. This tunnel should run from a dorsal, ulnar position on the triquetrum and in a palmar and radial direction to come out on the palmar side in the LT interval where the hole through the lunate exits. We place the tip of a drill guide (Wrist Drill Guide; Arthrex Co., Naples, FL) into the hole already prepared in the lunate and the sleeve of the drill guide where a K-wire should be inserted is placed on the triquetrum (►**Fig. 4A, B**). After having confirmed the correct position with the fluoroscopy, we drill a K-wire through the triquetrum as described. If everything looks good, we again use a 2.8-mm drill to make a hole through the triquetrum. We use a small curved curette in both tunnels to smoothen the surfaces, most attention is paid on the palmar side (that we do not see, but where the tendon should pass from one bone to the other).

To pass the tendon through the bones is the most technically demanding part of the procedure. We leave the arm on the operating table, enter the slip of the ECU tendon into a tendon passer (Quick Pass Tendon Shuttle, Arthrex Co., Naples, FL); however, it is in our experience not possible to pass the tendon shuttle through the bones directly due to the sharp angle on the palmar side where the tendon should pass from the triquetrum to the lunate. We therefore use a suture lasso (Micro suture Lasso, Arthrex Co., Naples, FL) armed with a wire loop, that we enter through the 3–4 portal into the lunate. With the fluoroscope we can visualize the wire loop at the palmar side of the LT interval. Through the bony tunnel in the triquetrum we fetch the wire loop with a suture hook, (Mini Suture Hook; Arthrex Co., Naples, FL), entered from the dorsal side of the triquetrum to be forwarded through the bone to the palmar side where the wire loop is located and pulled out to the dorsal side of the triquetrum. We have never had to make a palmar incision to help passing the wire loop from one hole to the other, however, this could be possible. After having passed a wire loop through both the lunate and the triquetrum, we put a 2–0 suture (FiberWire; Arthrex Co., Naples, FL) through the end of the tendon shuttle(►**Fig. 5A, B**). By pulling the wire loop from the 3 to 4 portal we can get the suture tied to the tendon shuttle through the holes. The tendon shuttle will follow; however, one should be careful to have secured the tendon shuttle to the tendon slip in order for the tendon to stay within the shuttle all the time. Passage of the shuttle on the palmar side of the bones could be difficult, but we have always succeeded (again, make sure to prepare the bony tunnels, to smoothen the edges of the openings) (►**Fig. 6A–C**). When the tendon shuttle has come to the 3–4 portal, we release the tendon and secure the end of the tendon with a mosquito. If there is a volar intercalated segmental instability (VISI) or a malposition between the lunate and the capitate, we will reduce the VISI by flexing the wrist to restore normal radiolunate angle. We will then temporarily use a K-wire drilled through the distal radius and into the lunate to secure the

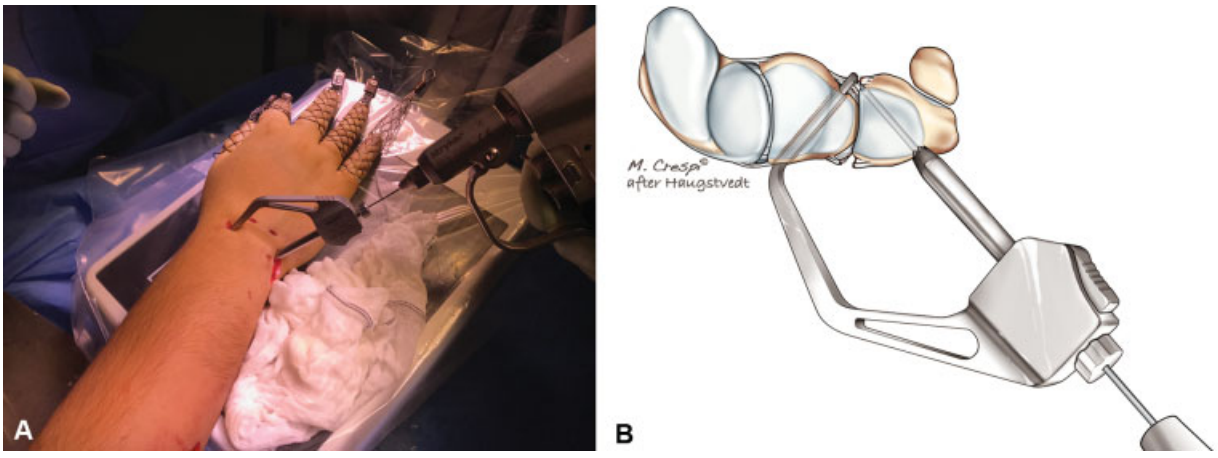

Fig. 4 (**A**) The tip of the drill guide is placed into the hole in the lunate while the other side of the drill guide is placed on top of the triquetrum. (**B**) A drawing illustrating the position of the drill guide. Image Courtesy: Wrist Arthroscopy Techniques.[9]

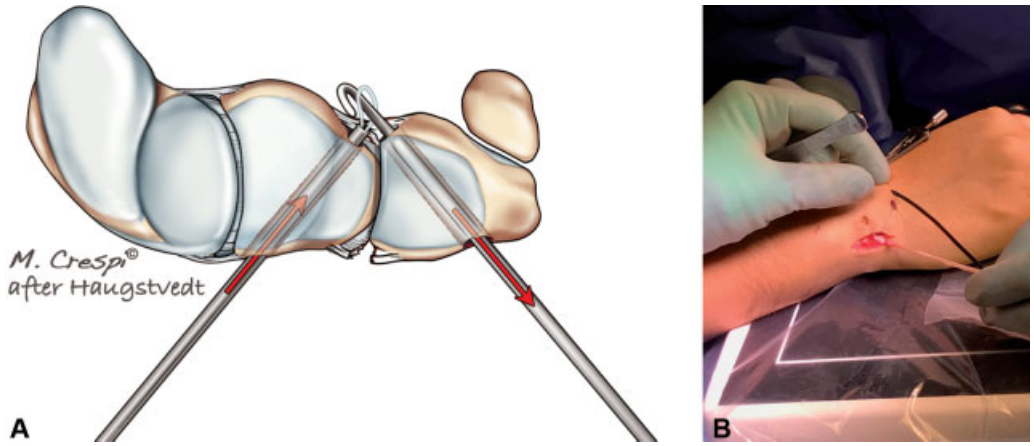

Fig. 5 (A) Passing of the wire loop through the lunate and the triquetrum. The wire loop is used to pull a suture attached to the tendon shuttle (with the tendon graft) through the bones. See text. (**B**) After having placed a suture in the tendon shuttle we put the suture through the wire loop which is then pulled through the bones. The tendon graft will follow. See text. Image Courtesy: Wrist Arthroscopy Techniques.[9]

reduction. For this purpose, we use a fluoroscope to check the reduction and avoid the tunnel in the lunate.

We then put the arm back in the traction tower and carry out arthroscopy of the midcarpal joint. We visualize the LT interval and by pulling the tendon graft we can verify that the LT interval closes. We now secure the tendon graft. First, we enter a PEEK screw (Tenodesis screw, PEEK, Vented, 3 × 8 mm; Arthrex Co., Naples, FL) into the dorsal triquetrum making sure the tendon is fixed in the bone. Following this we will fix the tendon in the lunate. We place the arthroscope in the 1–2 portal, view the exit of the tendon from the lunate and through the 3 to 4 portal we enter an identical tenodesis screw into the lunate while tensioning the tendon graft (►**Fig. 7**).

At this point the tendon graft should be brought back to the triquetrum on the dorsal side of the carpus and we put the arm back down on the table. From the entry point of the tendon graft on the dorsal side of the triquetrum, we pass a mosquito extracapsular, but palmar to the extensor tendons, to the 3–4 portal (►**Fig. 8A, B**). When this space has been established, we pass the tendon graft from the 3–4 portal to the triquetrum and we secure the tendon graft by passing it around the distal part of the ECU slip itself and fix it with nonresorbable sutures (►**Fig. 9**).

At this point the reconstruction is finished; however, we have chosen to proceed with one more step. In LT-lig injuries, and especially in those with a VISI deformity, we find injury or weakness of the dorsal radiocarpal ligament (DRC lig). This runs from radius to the dorsal side of the triquetrum. We feel reconstruction or strengthening of this ligament at the same time as reconstruction of the LT-lig is worth doing. Thus we always harvest a long tendon slip that is not all used up to this point; the remaining part of the tendon slip, after having been secured to itself, is now tunneled under the EDM tendon in a proximal-radial direction to the distal part of the radius. We verify the position using a fluoroscope and use a bone anchor (FASTak, Small Bone with 2–0 FiberWire; Arthrex Co., Naples, FL) that we insert into the dorsal edge of the radius. We tighten the tendon graft to this bone anchor, the wrist in a neutral position (►**Fig. 10**). We finalize the surgery by closing all wounds (►**Fig. 11**), then we apply an above-elbow cast. We believe that it takes 8 weeks for a ligament to heel, or to stabilize the wrist, thus the patients are immobilized for this period of time.

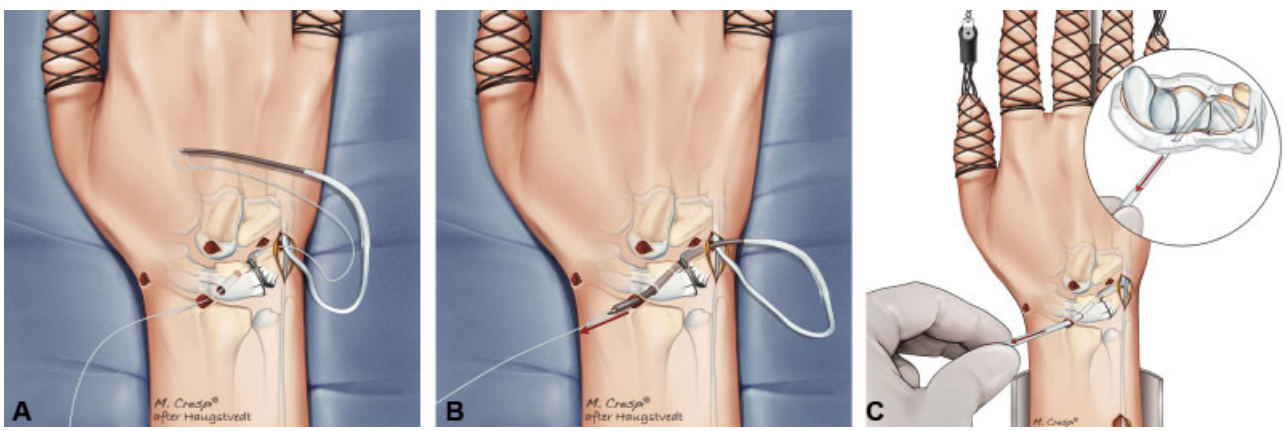

Fig. 6 (**A–C**) A suture is attached to the tendon shuttle which is then pulled through the triquetrum and the lunate to exit through the 3–4 portal on the dorsal side of the carpus. See text. Image Courtesy: Wrist Arthroscopy Techniques.[9]

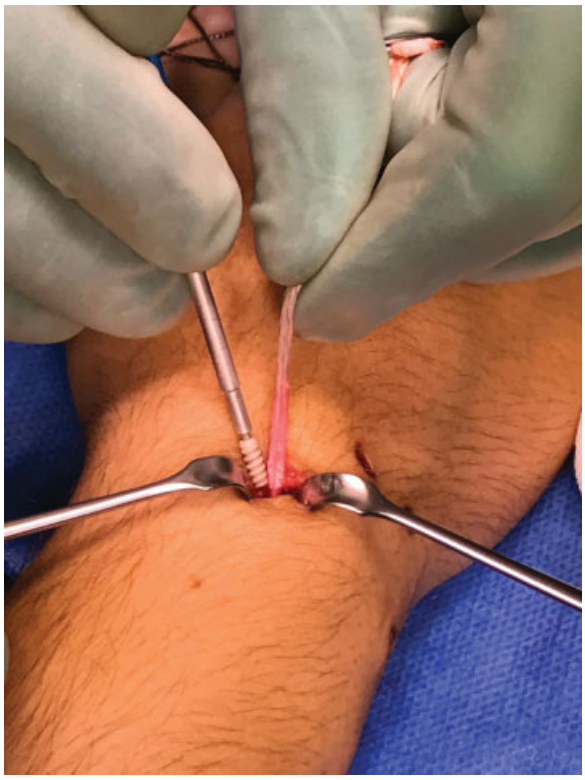

Fig. 7 We have the arm in the traction tower when checking that the LT interval closes while pulling the tendon graft. We then enter a screw (see text) into the triquetrum to secure the graft. We will then secure the graft in the lunate using another screw. This could be done while the arm is still in the traction tower or with the arm on the operating table (in figure). LT interval, lunotriquetral interval.

Fig. 9 The graft is sutured back to itself after having passed the tendon graft around the part of the remaining ECU tendon. ECU, extensor carpi ulnaris.

Results

Two patients underwent this procedure with more than 30 months follow-up. The first was a man born in 1993, a manual worker. He had a preop Q-DASH of 31 at rest and 100 at work. At follow-up, 32 months after surgery the Q-DASH score is 6.8 at rest and zero during work. This young man had a heavy manual work, has later changed his job where he has some office work and some manual work; he is now pain free.

The second patient was a man born in 1961, an office worker. He had an injury of his wrist half a year prior to surgery. Performing arthroscopy, we found a foveal detachment of the triangular fibrocartilage complex (TFCC) and an LT ligament injury (instability grade III, twisting of probe). The LT reconstruction was performed at the same time as a TFCC foveal reattachment was done. His preop Q-DASH score was 61 at rest and 85 while working. He had pain from the ECU tendon sheath after starting rehabilitation; thus, we had to reoperate to perform synovectomy. At this surgery we had a "second look" and found stability over the LT interval. He did much better following the last surgery. The second

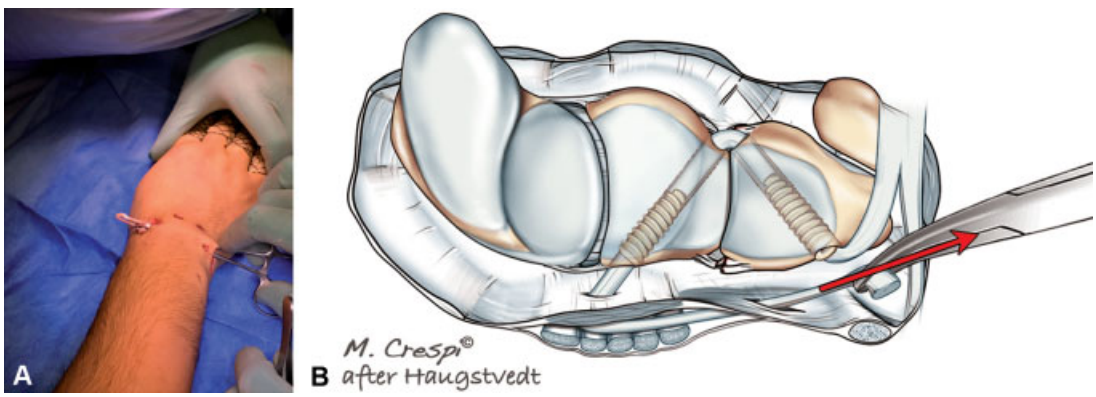

Fig. 8 (**A**) The tendon graft should be brought back to the triquetrum. We establish an extracapsular space palmar of the extensor tendon and pull the graft back to the dorsal, ulnar side of the carpus. (**B**) Illustration of the position of the graft that should be outside the capsule. Image Courtesy: Wrist Arthroscopy Techniques.[9]

Fig. 10 After having secured the tendon graft back to the ECU tendon, we make a tunnel do the dorsal ulnar corner of the radius to reconstruct the DRC ligament. We use an anchor to attach the tendon to the radius. This picture shows the part of the tendon that will be used for the ligament reconstruction. An approach has been made to the radius and a fiber loop is used to pull the tendon graft to the radius where it is attached to the bone anchor. DRC, dorsal radiocarpal ligament; ECU, extensor carpi ulnaris.

patient has recently had a stroke, a cerebrovascular insult, that sets him back. He is still at work, but the activity level (tennis, biking) is lower than usual. His Q-DASH score at rest is 2; he does not have any pain working (score 0).

Discussion

The aim for developing this technique was to come up with a method to perform a reconstruction that has been shown to work in clinical cases, however, without making exposures to the wrist cutting ligaments with a wide opening of the capsule and with the potential of disturbing nerves and thus proprioception. It is a technical demanding procedure where especially passing the tendon on the palmar side from the triquetrum to the lunate is a challenge. There is, however, a possibility to make a small incision on the palmar side if this is unavoidable.

We have in the cadaver laboratory tried to pass the tendon slip intraarticular on the dorsal side from the lunate to the dorsal side of the triquetrum. Without having performed any testing, we found the tendon being malpositioned when viewing the intracapsular graft by arthroscopic examination. Thus, we have chosen to place the graft extracapsular.

The graft is secured by two PEEK screws. In our hands the screws used seem to have fulfilled their purpose; however, it

Fig. 11 Closure of the wounds. Compare with the open surgery as shown in ►**Fig. 1**. Image Courtesy: Wrist Arthroscopy Techniques.[9]

is possible that a metal interference screw might give a better stability. We do not have any screw of this type available, and thus we have not been able to try this.

It is also possible that the tendon graft being brought back to the triquetrum should have been fixed with yet another screw. We have been careful with drilling another hole in the triquetrum and feel that the fixation described have been good. The end of the tendon graft is secured to the radius with a bone anchor, this seems to be stable and to work well.

So far, we have performed this procedure in two patients. Reconstruction of LT ligaments are not frequently performed; there are no larger series in the literature. This technique is a novel technique describing an already existing procedure, however, performed with different tools. As previously stated, the lesion itself is not so common, and this reconstruction is not a common procedure. To have a prospective, randomized study comparing the different techniques seems to be very difficult as collecting a sufficient number of patients will probably not be possible. However, if this method gains popularity, it could be possible to perform a prospective study including many centers where experienced surgeons performing wrist arthroscopy could participate and the open procedure should be compared with this arthroscopically assisted procedure. Both methods work well, however, with less scaring and less exposure of the wrist in the arthroscopically assisted technique, which we believe is for the benefit of the patients.

Ethical Approval

For this article, no approval of Ethical Committee was necessary.

Funding

None.

Conflict of Interest

J.R.H. reports personal fees from Arthrex, and others from AO, Medartis, and KLS Martin. I.Z.R. reports personal fees from Arthrex Inc., outside the submitted work.

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